



Translating Theory on Color-blind Racism to an Engineering Education Context: Illustrations from the Field of Engineering Education

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Abstract

Researchers across the engineering education research spectrum are investigating engineering and engineering education's persistent racial homogeneity. Administrators and instructors alike talk about how they want their classrooms to be more racially diverse, and yet despite the herculean efforts of "minority in engineering" programs and the like, the needle has moved little. In this position paper, we describe a theoretical lens developed in critical race theory that has so far had little influence in engineering education to thinking about race although we consider it to have ample affordances. This lens is a theoretical framework developed by sociologist Eduardo Bonilla-Silva called "color-blind racism," and comprises 4 frames: abstract liberalism, cultural racism, naturalization, and minimization of racism. Because the author team sees great value in understanding how cultural values and practices associated with a US experience of Whiteness have been built into U.S. engineering education, we offer here an articulation of these frames, and illustrate each frame through a curated set of stories drawn from our experiences as K-12 students, as undergraduate engineering students, and as engineering faculty at Predominantly White Institutions (PWIs) and Minority Serving Institutions (MSIs). We note some limitations of the color-blind racism theory as we have applied it, offer some practical applications of the theory to consider, and issue a call to action for both engineering education researchers and engineering instructors.

Introduction

This position paper aims to prompt engineering education researchers and engineering instructors to think about how engineering as a profession, and engineering education, have been structured as a predominantly White discipline, and how it maintains this demographic imbalance despite decades of calls and work to diversify it. As many researchers and federal reports have noted [1-3], women and men of color and White women participate in much lower rates in US engineering education compared to their representation in the general population, despite many overt efforts at many levels of U.S. society to broaden participation. There are calls to remedy this persistent problem; however, some of us have argued [4] that engineering education researchers can take as given the value of a diverse engineering profession, particularly with regards to gender and race.

A wealth of diversity research in engineering education research (EER) investigates race statistically – that is, demonstrating racial disparities by looking at the racial identifications of engineering students, faculty, or others, and noting statistically significant differences between racial groups along particular measures or constructs. While this research is no doubt valuable, most of the time the concept of race is itself uninterrogated. Researchers adopt the racial categories laid out by the National Science Foundation, themselves built on the Office of Management and Budget federal guidelines. But what does "race" itself mean? [5].

Scholars in other areas, including Critical Race Theory (CRT), offer frameworks in which to investigate race and racism other than looking at the statistically significant disparities among racial groups. In this paper, we offer Eduardo Bonilla-Silva's theory of color-blind racism as a specific frame from CRT that we believe might prove fruitful to investigate race and racism in engineering education. Bonilla-Silva and other CRT theorists have argued that, after Jim Crow laws were deemed unconstitutional, there arose a new means to maintain segregation without overt racism: through what Bonilla-Silva calls "color-blind racism" [6]. We situate color-blind racism theory in the context of CRT, note the places theorizing around colorblind racism is occurring in educational research, and offer several illustrations of its applicability to contemporary engineering education practices. We close with some ideas for EER researchers and engineering instructors to explore and consider in a call to action.

While this paper is not empirical in the standard sense, even though it is based on experiential data, it offers an exploration of the color-blind racism theory situated in an engineering education context. We offer our experiential analysis as a jumping off point to encourage other researchers to adopt it as a theoretical or methodological framework for empirical studies in EER, and for program designers to consider while designing future interventions to broaden participation in engineering education.

Background

We begin with a short discussion of the key theoretical contributions of CRT, then describe how it has been used as a framework in educational research, and then provide a short overview of how it has been used in engineering education research.

Theoretical contributions of Critical Race Theory

CRT has been used to understand racism as a system of advantage based on race rather than as a series of isolated acts based on individual feelings of hatred. Racism is considered endemic in American life and deeply ingrained legally, culturally and even psychologically [7]. CRT emphasizes that there exists a systemic - even normal - state of racism in the United States. Moreover, CRT has been applied to different fields that seek to analyze and critique programs, services, systems, and even artifacts. CRT proposes different tenets used to analyze systemic problems of racism in our society.

The first tenet is that racism is **normal** and it is a part of American life. "Racism is ordinary, not aberrational -- 'normal science,' the usual way society does business, the common, everyday experience of most people of color in this country" [8, p. 7]. Racism has become a "normal" feature of our lives. We see it every day through different discourses and everyday conversations, all levels of text and talk, visuals, sounds, semantics, and interactions among others [9]. Racism becomes normalized when, for example, there is preferential treatment in financial credit lending for White communities over communities of color without anyone questioning the racial patterns; or when crime prediction software is developed to determine where crimes are most likely to occur but explicitly target communities of color without anybody disputing the accuracy or development of the prediction models [10].

The second tenet involves **interest convergence**, which is the process by which the interests of people of color converge with the self-interest of Whites, and which is considered necessary for any apparent decrease in structural racism. Derrick Bell argued that the gains made by African

Americans during the Civil Rights Movement [11] only came about because the interests of African Americans converged with the self-interests of Whites in that White elite groups needed a breakthrough for African Americans for the sake of global appearances and competition [12]. In the end, however, he argued there were minimal to null gains in education after the *Brown v. Board of Education* decision because the decision also led to many schools closing and Black administrators and teachers being dismissed, which produced limited access to high-quality school curricula for many people of color [11].

The third tenet is the **social construction of race**, which indicates that race and races are the product of social thought that “invent[s and] manipulate[s]” what can be considered “pseudo-permanent characteristics” for race when convenient by the dominant race, and are “retired” when no longer convenient [8, p. 8-9]. For example, there have been a wide list of categories and characteristics used to measure race in the United States that have changed over the years. People could not self-select their own racial category in the census until after 1960 – instead, they were assigned a race based on phenotypical and linguistic features that conformed to the census takers’ conceptual models of race [13]. In some parts of the US, race was assigned primarily based on skin color and this determined what racially-segregated school children could attend. School segregation in the Southwest was considered a normative practice because definitions of race and the ideology of deficit thinking were manipulated to provide inferior schooling opportunities to communities of color. Children were forced to speak English and prevented from speaking any other language. Many Mexican American children were segregated into “Mexican” schools, and not allowed to speak Spanish in the classroom; those who were not perfectly bilingual in English were therefore perceived as intellectually inferior, dull, and phlegmatic [14]. Some school districts opposed segregation not because it was a discriminatory practice, but because it was too expensive and cumbersome. Instead, schools placed Mexican American children who could pass as “White” in the same schools as White children, as long as they “looked White” and showed symbols of apparent prosperity and cleanliness [14]. This flexibility of racial segregation helps illustrate the social construction of race itself.

The fourth tenet is **differential racialization**, which indicates that racial groups have been racialized in different ways in response to different needs of the majority. For instance, the Bracero Program included a series of diplomatic agreements initiated during World War II that allowed Mexican nationals to temporarily work in farms in the United States [15]. It has been well documented that the Bracero Program had a significant positive impact in the business industry and economy of the United States [15,16]. However, at the same time, racist images of Mexicans as inherently dirty provided justification for spraying Mexican workers with dichlorodiphenyltrichloroethane (DDT) - a virulently toxic substance - before working in the fields [17]. This and other similar racist images also functioned to deport (“repatriate”) many Mexican Americans to Mexico even though they were U.S. citizens [15]. Some states did not follow the workers’ rights stipulated in the Bracero Program agreements, which led people – racist extremists to average Americans – to discriminate against Mexicans by promoting segregationist practices [17]. This episode illustrates how a dominant White culture racialized Mexicans and Mexican Americans as a racial group to justify their inhumane treatment undergoing DDT contamination while simultaneously making use of their labor for economic gain.

The fifth tenet is **intersectionality**, which indicates that race and racism intersect with gender, class, sexuality, language, nationality, ethnicity, culture, and immigrant status among others [8]. As Delgado and Stefancic have articulated, “no person has a single, easily stated, unitary identity” [8, p. 10]. This tenet also acknowledges that racism is not a binary issue (e.g., Black vs White), but that it affects everyone in society because of the complex system of social advantages and disadvantages associated with race and other social constructs and identities. Intersectionality reminds us that it is important to recognize that when one type of oppression is discussed without acknowledging that there are other oppressions connected to multiple social identities, the dialogue only revolves around the experiences of the most privileged while dismissing and erasing the experiences of the more socially marginalized [18,19]. Crenshaw [19] developed the framework of intersectionality to describe how power collides and intersects with different social identities, and how individuals, groups of people, and social problems are created by multiple sources of oppression.

The sixth, and final, tenet is **counterstory**, which recognizes experiential knowledge as legitimate, appropriate ways to critically theorize systems, organizations and structures [8]. CRT recognizes the experiential knowledge of people of color and other subordinate groups (e.g., women and those of the LGBTQ community) as valuable and necessary to understanding, analyzing, and teaching about racial subordination [8,20]. CRT explicitly acknowledges the lived experiences of subordinate groups through storytelling, family histories, parables, and narratives.

CRT also disputes claims of objectivity, meritocracy, color-blindness, race neutrality, and equal opportunity, asserting that these claims hide the self-interest, power, and privilege of dominant groups. Proponents of CRT believe in a social justice agenda with the goal of eradicating racism for all subordinate groups. CRT is analyzed and examined through historical and contemporary lenses knowing that ideologies from the past inform and dictate current practices.

Critical Race Theory as a Framework.

CRT has been used as a research framework to analyze issues of prejudice, discrimination, and inequality in different fields. In legal studies, for example, critical race theory transformed critical legal scholarship by diversifying its discourse [21]. CRT originated from the need to address “issues of power, race, and racism to address the liberal notion of color blindness” [22, p. 9], and to challenge the status quo of a legal system that was deeply unjust to racial minorities [8]. Some of the most prominent contributors to this type of legal scholarship include Derrick Bell [11,23-25], Alan Freeman [26], Richard Delgado [8,27-29], Patricia Williams [30,31], Kimberlé Crenshaw [18,32-34], and Mari Matsuda [35,36], among others. CRT in legal studies recognizes that racism remains a foundational factor in U.S. society [8]. Using an analytical and critical lens, legal scholars have examined power structures created in society through the operation of “normal” White supremacy and White privilege [22]. It is through CRT that scholars have been able to deconstruct issues of racism, discrimination, and more broad systemic inequities impacting people of color through the legal system. For instance, Delgado criticized the argument that affirmative action provided “role models” for people of color [28]. He argued that affirmative action created a system where, instead of creating role models, the role model argument provided a disempowering device that served the dominant majority more than people of color. Delgado argued that people of color would be “hired if you speak politely, have a neat haircut, and above all, can be trusted, not because of your accomplishments, but because of what others think you will do for them” [28, p. 1226]. Matsuda also problematized the impact that

affirmative action could have on faculty of color, where the “role model” serves more as an assimilationist method rather than a way to amend errors from the past [35]. Delgado indicated that the “role model” argument impacted people of color because it forces individuals to adopt majoritarian social norms that emulate past historical systems of oppression [28]. Overall, CRT in legal studies created a movement that was intended to challenge the traditional legal culture to analyze the legal system and expand the conversation about race, ethnicity, and gender subordination.

In addition, CRT has been adopted in other fields like education. The term “Critical Race Theory” was first used in education in 1994 to reference an analytical framework to analyze inequity in education [37]. Ladson-Billings and Tate used the framework to analyze how schools are structured in a way that perpetuates inequality as a result of a racialized society [38]. They argued that CRT could be used as a tool to achieve educational reform and promote multicultural education in schools. Ladson-Billings and Tate make a particularly important argument around the fact that U.S. society is based on *property rights*, and argue this idea has created the permanence of racism in the U.S. [38]. They asserted that the development of the Constitution created a tension between property rights and human rights, and that the purpose of the federal government was to protect property (e.g., slaves) and protect the rights of slave owners to have their “property.” In contrast, the government was not incentivized to secure human rights for African Americans. The narrative of “property rights” has had detrimental implications for education. Property can be seen not only as material artifacts, but also in terms of “intellectual property” [38]. For example, affluent communities, with high property values, pay property taxes to support their local public school system, resulting in affluent school systems. Affluent communities have also historically refused to pay for the schooling system of less affluent communities, ones which also (through systems of legal racial discrimination) are more non-White [38,39]. Better property means entitlement to better education for those with such property rights, while also sustaining more educational inequality. In addition, the quantity and quality of the curriculum also varies according to property value [38] because the curriculum determines what types of knowledge are valued in school [39,40], and what educational materials are provided to support students’ learning [38].

In similar ways to this last point, CRT has been used to challenge claims of objectivity and color-blindness in education. Calabrese argued that school policy reinforces White and White-centered curricula while suppressing the ways of knowing, doing and being of people of color [41]. Ladson-Billings argued that with so many White teachers, there are only a few voices that are able to challenge the deeply ingrained myths of color-blindness and meritocracy [42]. Valencia and Solórzano indicated that many White teachers have unjustifiably low expectations of students of color, perceiving them as underachievers whose shortcomings are directly linked to familial deficits and dysfunctions [43]. This paradigm places the blame on the students themselves and their families, rather than prompting the dismantling of institutional and legal structures that produce a system that does not provide equitable and democratic schooling for children based on race. Given that many teachers are White, and that most students of color will receive their formative education from White teachers, it is important to ask ourselves how issues of racism and color-blindness impact what we teach, how we teach, and why we teach.

CRT in Engineering Education Research

Scholars doing engineering education research are beginning to incorporate CRT into their work on diversifying engineering. We did a somewhat systematic review of the literature to assess where EER scholars are adopting and applying CRT. We did a full-text search of the Journal of Engineering Education, the International, European, and Australasian Journals of Engineering Education, Advances in Engineering Education, and the proceedings for the annual national conferences of the American Society for Engineering Education and Frontiers in Education. We used the search terms “critical race theory,” “colorblind,” “color-blind,” “funds of knowledge,” “community cultural wealth,” “race discrimination,” and “racism,” based on an assessment of controlled search terms offered by Academic Service Premier and our expertise working in the field. We included the specific theories of funds of knowledge and community cultural wealth because of how they derived from asset-based approaches to education through a CRT lens [20,38,40]. We decided to exclude the term “intersectionality” even though it is a core idea of CRT, because of the explosion of usage of the term of which we were already aware. In Table 1, we report the number of instances we found prompted by the collection of search terms.

Table 1
Engineering Education Research

Source, ordered by frequency of findings	Number of instances prompted by search terms
<i>ASEE Conference Proceedings</i>	75, excluding those generated by term “racism” which brought an additional 120 instances
<i>Frontiers in Education Conference Proceedings</i>	14
<i>International Journal of Engineering Education</i>	12
<i>Journal of Engineering Education</i>	8
<i>European Journal of Engineering Education</i>	4
<i>Australasian Journal of Engineering Education</i>	0
<i>Advances in Engineering Education</i>	0
<i>AAEE Conference Proceedings</i>	0

Archival journals: Of the set of papers published in *JEE*, four used the phrase “critical race theory.” While in one it was a trivial reference (CRT was in a reference and nowhere else in the paper), the other three had aspects of CRT core to their argument, design, or analysis [44-46]. Of the remaining four papers in *JEE*, one had community cultural wealth at its core [44], and one used multiple concepts associated with CRT throughout [47], while the remaining two were minor [48] or tangential references [49]. We found 8 initial hits in *EJEE* but four were false hits - “blind” didn’t refer to color-blindness even in the visual sense, let alone the racial sense. The remaining four in *EJEE* listed in the table were identified through the term “racism” and did not relate to CRT. In *IJEE*, 8 papers related to “racism,” one to “race discrimination”, one to visual

color-blindness, none to community cultural wealth, but one each to CRT [50] and funds of knowledge (although this latter reference was very minor) [51].

Conference proceedings: The patterns in the *ASEE* and *FIE* proceedings are more heartening. There is a considerable amount of material that make the tenets of CRT the core of their argument, method, or interpretation. Fourteen out of 89 papers reference more than one search term; only 1 of these referencing multiple terms was published at FIE. Across these two conferences, we see 36 references to funds of knowledge, 18 to colorblindness in some form, 12 to community cultural wealth, and 45 to CRT more generally. A rough scan of titles and abstracts suggest that the majority of the sources authentically referenced these theories (such as in the “colorblindness” example mentioned earlier), although some also included trivial instances (in that the terms appeared in author biographies or in references only). There were no references to any of the search terms found in the *AAEE* conference proceedings.

From this rough overview, it seems clear that engineering education’s conferences are the places where CRT is increasingly being used. This is unsurprising, given that conferences are the places where new ideas might be offered and accepted sooner than in archival journal publications, conferences are where new scholars may be bringing in more new or interdisciplinary theory, and conferences have a lower bar for scholarship allowing adoption of more controversial ideas. We note also that race as constructed in the United States is its own peculiar thing, which could explain why there are no relevant sources in *IJEE*, *EJEE*, *AJEE*, and *AAEE*; that being said, CRT has also started to be adopted in broader educational (but not engineering educational) contexts in the UK, Australia, and New Zealand, despite these countries’ different histories and relationships to race.

Color-blind racism theory

For the purposes of this paper, we adopt the theoretical framework offered by Eduardo Bonilla-Silva, in his book *Racism without Racists* [6]. Based on an empirical study of White university students and older workers, he articulates a structure with four main frames. Bonilla-Silva defines **abstract liberalism** as the practice of using ideas drawn from political and economic liberalism to explain racial matters (such as using “equal opportunity” as a means to achieve social policy, or “choice” to explain neighborhood segregation) and sees it as the most important of the color-blind racism structure. He describes **cultural racism** as “a frame that relies on culturally based arguments to explain the standing of minorities in society”, and **naturalization** as an explanation of race-based patterns as “natural” occurrences. The last frame is **minimization of racism**, which is the idea that racism no longer materially affects racial minorities’ experiences and opportunities.

This framework is not the only one available to scholars to investigate color-blindness. An alternative frame is offered by Forman, Reason and Evans and includes four tenets: “1. racial groups receive merit-based privileges, 2. most people do not notice nor are they concerned about race, 3. social inequality today is due to “cultural deficits” of individual people or racial or ethnic groups, and 4. given the previous three assumptions, there is no need to pay “systematic attention” to any current inequities [52]. They argue the prevalence of color-blindness is partially attributed to lack of knowledge or lack of exposure. Due to segregation that exists in housing and education, many Americans may not have direct contact with the discrimination that still exists” [53]. We have chosen to adopt Bonilla-Silva’s framing of color-blindness because of its

prominent usage throughout CRT and because it was initially conceived of through interviews with undergraduates at university, allowing us to maintain a connection with higher education.

Illustrations

For the remainder of this paper, we present specific illustrations drawn from our experience as scholars working in higher education. Alice Pawley is a White, native English-speaking, class-privileged tenured faculty member at a predominantly White institution in the Midwest US. She came to studying race in engineering education through initially studying gender and then learning about intersectionality theory. Renata Revelo identifies as Latina and is an immigrant from a developing country of South America and a non-tenure track faculty member at a minority serving institution in the Midwest US. Renata was drawn to the study of social identity because of her experiences and observations as a woman of color in engineering education. Joel Alejandro (Alex) Mejia identifies as Latino and is a tenure-track faculty member at a predominantly White institution with a religious affiliation in the Pacific West. He became interested in issues of race and social justice because of his transnational experiences, and his journey as an engineer working for the military and mining industries. As does everyone, we each inhabit different additional intersections of social identity than those we have identified here.

Method

We initiated this paper after participating in ASEE 2017 in Columbus, OH. One of us attended sessions by the other two of us, and thought that we might share an interest in exploring the topic of color-blindness in engineering education. We developed this paper through a series of conversations held over multiple months, where we explored the different dimensions of Bonilla-Silva's color-blind racism theory and shared stories about experiences of discrimination and racism we have experienced or seen first-hand, and discussed whether they fit into the framework, or whether they constituted other (one might say "non-colorblind") forms of racism. Some stories we experienced contemporaneously to our discussions, while others we did not. While we had a wealth of contemporary material from which to choose, we strived to select the stories that were most oriented to the dimensions and situated in engineering education itself.

We now address each of Bonilla-Silva's frames in the order in which he presents his theory, offer our illustrations, and discuss their relevance to thinking about race in engineering education.

Abstract liberalism

Bonilla-Silva defines the color-blind frame of "abstract liberalism" as involving "using the ideas associated with political liberalism (e.g. "equal opportunity," the idea that force should not be used to create social policy) and economic liberalism (e.g., choice, individualism) in an abstract manner to explain racial matters" [6, p. 76]. He describes it as the most important and insidious aspect of color-blind racism, and offers examples of how White people in his study used it. For example, he illustrates how White people have used the notion of equal opportunity to disparage affirmative action policies, arguing that it privileges certain groups yet simultaneously overlooking how policies have quietly privileged White people both historically and contemporaneously. Another example he offers is:

...regarding each person as an “individual” or with “choices” and using this liberal principle as a justification for whites having the right of choosing to live in segregated neighborhoods or sending their children to [de facto] segregated schools. This claim requires ignoring the multiple institutional and state-sponsored practices behind segregation and being unconcerned about these practices’ negative consequences for [racial] minorities [6, p. 76].

Taking these two examples, we look to see where the frame of abstract liberalism makes itself useful in maintaining engineering education as a predominantly White space.

In conversations about the low numbers of people of color admitted into engineering education, we hear two regular lamentations. One is that the few people of color who do apply and who we (as an institution) want to admit have so many other schools also wanting them to attend. Because these prospective students of color have so many options, it is unlikely they will choose to come to our institution, and so perhaps we should not admit them in the first place. We see this logic as a form of abstract liberalism, analogous to the idea that people get to choose where they live: governments/organizations can’t force people of color to (in this case) choose to come to our university, and we don’t want to admit people who will turn us down, therefore we don’t admit them and continue to have low numbers of people of color. However, the consequence of therefore not admitting students of color because they will likely have other options is a self-justifying rationale: by not admitting them, students of color will certainly not come to one’s institution.

The second lamentation comes from a contrasting logic: that we need to treat all applicants the same, so we cannot recognize how race may adversely influence some individuals’ circumstances. This tends to be offered in conversations that also involve the argument about “lowering standards” or “dumbing things down” - that we as an institution cannot “lower our standards” in order to admit more people of color or to meet students where they are academically when they enter our programs. This argument ignores that the access of applicants of color to high quality education may be markedly different from White applicants with the same application profile. In other words, a student who comes from a poor school district with no AP course offerings getting a reasonably high standardized test score may arguably demonstrate markedly more merit than a student who comes from a wealthy school district with many AP course offerings with that same standardized test score. Because of the intersection of race and class in the U.S. as a function of historical racist economic policy and a history of residential segregation, K-12 students of color are more likely than their white peers to come from poorer K-12 school districts [54,55]. In connection to color-blindness, by using abstract liberalism around the idea of equal opportunity, this lamentation and desire to “treat all applicants the same” fails to acknowledge unequal pre-college preparation as a systemic factor.

The third example we offer is the belief in meritocracy; Bonilla-Silva explicitly includes meritocracy in the “abstract liberalism” frame [6]. The idea of meritocracy is that people receive reward based on merit - that they earned reward through their actions. The corollary of this claim is that people without reward earned their lack of reward, or otherwise did something to deserve that reward. Applied to higher education, students deserve to be admitted to universities through their hard work and accomplishments, and people should not be admitted to university if they have not worked hard and earned the admission. Considerable research debunks this belief from

reality, offering empirical and theoretical evidence as to how hard-working people of color and White women throughout education and employment do not receive the same rewards as White men, demonstrating how the majority of people do not operate in a meritocracy [47,56]. Seymour and Hewitt's *Talking about Leaving* [57] may be one of the most well-respected studies debunking this myth, demonstrating that a large majority of students who left STEM undergraduate majors left not because their grades were poor (as would be suggested from the meritocracy myth) but because there are other factors that push them out.

In our experiences as engineering faculty, we hear versions of the meritocracy myth through the idea that students must prove themselves to be engineers, and they will make it only if they work really hard through the "death march" of math and science courses [58]. In this example, we argue that the idea that students need to prove themselves in the curriculum and that if they work hard enough [59], they will make it is a form of abstract liberalism. Using this perspective allows us to overlook or ignore factors other than "not working hard enough" to explain why students are "leaving" engineering. In other words, we come to accept that only those students who make it through engineering on "their own merit" (because they worked "really hard") are the students worthy of the profession. Operating from this meritocratic point of view can lead to practices that enable pushing out students via unrealistic policies and expectations. Instead, this idea could be reframed (as some engineering programs and institutions have done) as: given the varied pre-college experiences that engineering students have, what aspects of engineering education are unnecessary or unrealistic, and for which students?

We also regularly hear fears from racial majority students about how a meritocracy may be working against them. For example, one of us offered the example that our White students feel like they are being marginalized because they do not receive academic scholarships, and theorize that this is because "most scholarships are for students of color." The implication is that the White student his or herself is worthy of a scholarship, but that a student of color only received it because of their race, not their worth. Another example is from engineering graduate students, particularly White men, who express concern that they will not get a job because all the desirable jobs will go to women and people of color. By observing how industries use the pipeline metaphor to explain why they hire even smaller proportions of people of color than are available from undergraduate programs, we can see these fears are not borne out by reality. However, the fear persists, bolstered by a belief that a functioning meritocracy should reward predominantly White people for their accomplishments, but if it rewards people of color, then the meritocracy must not be operating correctly.

One of the consequences of engineering education maintaining the myth that it operates a meritocracy is that it (and the actors who work within it) remains absolved of any responsibility to rehabilitate how race is built into earlier stages of the educational system. The primary idea of meritocracy is that individual accomplishment will result in individual benefit and reward. However, it is also the idea that individual accomplishment can be segregated, divorced from a history of exploitation on one's behalf. So the meritocratic myth applied to race in engineering education will imply that White people (and male White people in particular) have not received affirmative action over history to position specific White individuals in such a place that their individual accomplishment is rewarded. In other words, the implication is that White people have secured their position as the dominant race in engineering and engineering education in particular through their own merit, not because of a history of affirmative action operating on

their behalf. However, historians have unearthed educational policies that have an explicitly racist history, such as how the GI Bill benefits after World War II were inequitably applied by race, and because of a racially segregated higher education system Black veterans had fewer options to apply what meagre benefits they were awarded [60,61]. Such policies functioned to keep higher education, including engineering, predominantly White, and the maintenance of the meritocratic myth helps continuously erase how those policies provided unequal advantages based on race to White people [62-64].

Naturalization

Bonilla-Silva describes the naturalization frame as “a frame that allows whites to explain away racial phenomena by suggesting they are natural occurrences. [...] By suggesting these preferences are almost biologically driven and typical of all groups in society, preferences for primary associations with members of one’s race are rationalized as nonracial because ‘*they* (racial minorities) do it too’” [6, p. 76].

Our illustrations of this frame relate to the notion that the small number of people of color in engineering is a result of natural occurrences, not to systemic oppression. For example, one of us regularly hears from engineering faculty and staff the argument regarding both student admissions and faculty hiring that “We don’t have many people of color in our application pool because the [supply] pool is very small.” In other words, because of the small number of people of color who earn PhDs, the number of people of color applying for faculty positions will be small. We can work this excuse back through the pipeline - because of the small number of people of color who graduate with bachelor’s degrees, the PhD applicant pool is small, or because of the small number of people of color who graduate high school, the bachelor’s program applicant pool is small. The problem with this reasoning is that it never interrogates what structural features produce a “small pool” but takes as inevitable the truth of the statement, the concept of a pool and its size, and the absolution it provides the speaker (or institutional level) of any responsibility for relying on a system which produces small pools through structural inequality. It suggests that because people of color are numerical minorities in the general population, it is “natural” to expect “leaks” from the educational pipeline and have progressively fewer in engineering bachelors’ programs or faculty applicant pools. However, this “natural” reasoning could equally be applied to White people - but is not. While not all White people become engineers and while White people also “leak out” of the educational pipeline, the explanation for this is not naturalized in the same way as when applications are related to underrepresented racial groups. Operating from this train of reasoning allows committees to reconcile with not including any students or faculty of color in their pool of candidates instead of making short-term or long-term efforts to ensure that there are faculty of color candidates, or by replacing an assimilationist selection method (as described by Matsuda [34]) with one that embraces the material realities and embodied knowledges of faculty of color. This train of thought also allows committees to remain unaware of the extensive history of affirmative action advantages accorded to White people of which White candidates today are the “hereditary” beneficiaries. We argue this functions as a naturalization argument in that it accepts as inevitable (or “natural”) the small number of people of color who might apply to an institution instead of prompting the speaker and its institution from seeing small numbers as produced through racist phenomena.

In another example, some of us have experience being educated in English as a Second Language (ESL) programs in K-12 contexts, bringing together the intersection of race, ethnicity, and language. It was our understanding in those experiences that the existence of an ESL program - that is, the philosophical choice to isolate in a segregated environment second-language learners from native English speakers - was a “natural” thing to do, that its worth was not questioned. As participants in those ESL systems, we also experienced the poor quality of science and math courses offered to ESL students compared to AP coursework offered to native English speakers. In some cases, staying in the ESL track precluded us from taking any college preparatory math or science courses [65]. While we might understand the logistical difficulty in finding instructors who can offer college preparatory courses to students who also are simultaneously learning English, it is clear that such an approach also functions to track academically talented ESL students into educational tracks that are not expected to go directly into four-year institutions [65]. Given that engineering curricula favor students who take math and science college preparatory courses in high school, the naturalized idea that dual-language learners should be isolated in ESL courses also functions to prepare them more poorly than native English speakers – those who dominate what is considered the *lingua franca* for science [66] – for enrolling in engineering bachelor’s programs.

Cultural racism

Bonilla-Silva introduces the concept of cultural racism as defined as “a frame that relies on culturally based arguments such as “Mexicans do not put much emphasis on education” [...] to explain the standing of minorities in society” [6, p. 76]. This is a frame that relies on negative culturally-based arguments to create cultural explanations of why people of color are inferior. The frame also presumes a biological inferiority that is based on race or ethnicity to portray their cultures in a negative way, despite the wealth of evidence demonstrating how race is a social construct and not a biological reality.

Recently, a legal scholar working at one of our institutions co-authored an op-ed claiming that “all cultures are not equal” [67]. The article claimed that there are some cultures that are more suitable to be productive in advanced economies like the U.S. African Americans, Latinxs, and Native Americans were portrayed as individuals whose cultures were “incompatible” with what is required by democracies and free-market economies. The authors also claimed that the “bourgeois norms” of the “ordinary Americans” has been abandoned and replaced by the cultures of people who simply do not fit in [67]. To quote the op-ed:

All cultures are not equal. Or at least they are not equal in preparing people to be productive in an advanced economy. The culture of the Plains Indians was designed for nomadic hunters, but is not suited to a First World, 21st-century environment. Nor are the single-parent, antisocial habits, prevalent among some working-class whites; the anti-“acting white” rap culture of inner-city blacks; the anti-assimilation ideas gaining ground among some Hispanic immigrants. These cultural orientations are not only incompatible with what an advanced free-market economy and a viable democracy require, they are also destructive of a sense of solidarity and reciprocity among Americans. If the bourgeois cultural script — which the upper-middle class still largely observes but now hesitates to preach — cannot be widely reinstated, things are likely to get worse for us all.

Despite the problematic rhetorical strategies these authors employ (such as failing to provide evidence for upper-middle class people “hesitating” to preach the benefits of education, and making a racial argument which conveniently overlooks the racial overtones of who constitutes an “upper-middle class”) we expect there are many in engineering who agree with the substance of this argument. While this example is not directly situated in engineering, our students and faculty are still impacted by this problematic rhetoric. Engineering students and faculty do not just engage in engineering culture; they also engage in broader academic or public culture where such arguments – that cultural factors are to blame for the systemic injustices faced by people of color – are common. This type of narrative sets the tone to blame the victim. People use similar rhetoric to minimize the contributions of people of color to society [68-70], even though there are of course a wide variety of contributions to engineering, and society in general [71-73] that emerge from the cultures of those who are described as “incompatible” and not aligned with “bourgeois norms.”

In engineering education, hard work, self-discipline, and respect for authority are the “bourgeois norms” that must be followed to achieve success in engineering. Godfrey and Parker argued that, for many students and faculty, learning engineering involves engaging in difficult tasks, and those who succeed are those that can endure the workload [59]. Only those who are willing to take up this challenge and work extremely hard accomplish the goal of becoming engineers. This problematic belief is echoed in the “weed out” system engineering departments create and described by Seymour and Hewitt [57]. This belief creates a culture where engineering is seen as a field that is *reserved* for those who can endure the tough courses. At the same time, the realities and lived experiences of students of color such as around microaggressions and daily discrimination are neglected. There is an “unquestioned assumption” that knowledge in engineering is race- and gender- free [57]. There seems to be no recognition of the ethnocentricity of the curriculum and the accepted epistemologies. Although students of color are “holders and creators of knowledge” [68, p. 106] and contribute to the engineering field, this knowledge differs from the perceived “bourgeois norms” in engineering.

Classical engineering education philosophy situates engineering as a field where the ways of thinking, doing and being are methodological, technological, and objective [74]. It is a field that has been mostly established by White men who have decided what is engineering and who gets to participate [74]. There is also no recognition to different epistemologies and solutions to engineering problems, and designs are thought to be race and gender free [59]. In the United States, engineering has seldom been framed as a social justice profession and, as Cech has argued [75], ideologies of depoliticization and meritocracy held by many engineers make it extremely difficult to frame the profession in such a way. Instead, engineering is framed as purely objective, meritocratic, and composed of rigorously-constrained problem solving [75]. While “improving society” is part of many definitions of engineering as a profession, doing engineering work to claim justice for a specific group of people or cause takes a back seat and is unmarried from the goal of “improving society.” Instead, the idea of improving society is often broad or vague and does not necessarily address tenets of social justice. One of us offers the illustration that, while in discussion with fellow faculty members about the student body at one of our institutions, a faculty member expressed that minoritized students choose majors outside of engineering because these students are attracted to social justice professions instead of engineering. This faculty member’s statement was left unchallenged at this discussion.

While the false binary created between social justice profession and engineering is problematic, through this illustration we want to focus on how framing the lack of minoritized students in engineering as a cultural problem (e.g., minoritized students want to pursue culturally-relevant professions) makes it justifiable to leave unquestioned the broadly accepted definition of engineering as an objective, acontextual, problem-driven profession [75]. In other words, the frame of cultural racism is evident in this faculty member's statement in that it explains away the lack of minoritized students in engineering to their "culture" rather than that of engineering. In contrast, this sentiment could have been framed as "how can we re-define engineering in our classrooms to make it more attractive to students from minoritized backgrounds?"

Minimization of racism

Bonilla-Silva describes the final frame of "minimization of racism" as "a frame that suggests discrimination is no longer a central factor affecting minorities' life chances" [6, p. 77]. Our first illustration comes from one of the authors' experience teaching in a first-year engineering course during spring 2017. This course is taught in multiple sections of 120 students who are organized into teams of 3 or 4, and we use a team evaluation tool multiple times during the semester to assess how well the teams work together. This particular semester, two particularly important events related to race happened: the White supremacist rally in Charlottesville, VA on August 12, 2017 and subsequent violence, and the repeal of the Deferred Action for Childhood Arrivals (DACA) program. Conversations about race were occurring more frequently in engineering education outside of the frame of broadening participation. In the context of this teaching, however, Alice had a team of four White-presenting students, and during the team evaluations, one teammate noted that another teammate's racism was disrupting the team's work. She read these comments, and thought about what to do about it, but to her shame and guilt, ultimately did nothing, because she did not know what to do. Through this event, however, she realized how the course's team evaluation practice does not ask people whether teammates display overt racist or sexist behavior, nor identify this as flags to instructors interpreting the resulting data. Both Alice, as a White person, and the designers of the team evaluation designing in a predominantly White environment, were operating as though overt racism does not exist, or manifest itself in team dynamics, or require monitoring and then instructor intervention, even though the tool supports instructors intervening in other forms of team dysfunction.

Our second illustration builds on the meritocracy argument offered in the "abstract liberalism" section. We regularly hear that engineering is objective, "value-neutral" in content, that gender and race and similar demographic categories have nothing to do with and have no place in the technical body of knowledge that engineering values and maintains [59]. The intended outcome of this argument is that engineering itself as an educational field cannot therefore be racist - after all, how can the laws of thermodynamics, or calculus, be racist? Leaving aside the question of whether this is true (as STS scholars and others have long problematized), engineering education as a system operating at a university level still relies on the K-12 educational system to "supply" it with new students to educate. (While the factory metaphor of education is of course problematic, it helps us illustrate our point here.) Numerous scholars have pointed out how racial inequalities are baked into the K-12 system -- for example, how students of color as early as preschool receive more frequent and more severe disciplining than White students despite similar behaviors [76,77], how schools where students of color are the majority are often the most underresourced, or how the historical accomplishments of White people are magnified and generalized as "American" while the historical accomplishments of people of color are

minimized and relegated to “special topics,” or how social studies curricula reinforce colonizing notions of “us” vs “them,” relating “us” to White accomplishments and “them” to indigenous people colonized by White people, and erases how racism complicated the purported goodness of the Founding Fathers and their peers [78]. Even if we limited our gaze to these few examples, we could argue that students (of all races) leaving K-12 schools where these ideas are normalized have been pushed to adopt White supremacist logics, naturalizing as good and representative the actions of White people, and framing the contributions of people of color as isolated and problematic. By claiming value-neutrality while failing to problematize those racist logics when high school graduates come to engineering education at university, engineering education as an institution (and the actors who make use of this claim in engineering education, including instructors, administrators and policymakers, and researchers) becomes complicit in maintaining them. So engineering education has minimized the structural racism both White students and students of color experience in K-12 systems by accepting students who are a product of those systems while pretending itself meritocratic. In blunt terms, engineering education lets K-12 education do its dirty work for it, and keeps its hands clean - “lily-white,” one might pun.

Discussion

We summarize the 4 frames of color-blind racism and our illustrations in Table 2.

This color-blind racism framework allowed us to dig deeper into the comments, lamentations, arguments, and ideas we have heard in the past, and continue to hear regularly in our experiences as engineering faculty. In our conversations, writing, and analysis of these illustrations, we regularly wrestled with how to characterize each illustration, with one person arguing for its filing in one category, and another pushing a different one. Bonilla-Silva notes that people use these frames in combination more often than in pure form [6, p. 78] and with different emotional tones. This seems to explain our experience, and perhaps our difficulties show us how the illustrations don’t fall neatly into one category or another.

Because of our interest in how race is built into structure, and engineering education institutional structure in particular, we have tried to maintain a clear line of sight onto how the particular story related to structure. In future work, some of us are interested in pursuing how these logics, either singly or in combination, are built into the structure of engineering education institutions through policy, written documentation, and practices.

We also feel there are many opportunities for future work to link the color-blind racism framework to other critical theories around power and oppression. For example, while intersectionality is a core tenet of CRT, we did not see much discussion of it in Bonilla-Silva’s original work, although Crenshaw’s original theorizing [19] came early enough for there to be, and although we see clear opportunities for overlap (in our illustrations, we have noted the confluence of race and language discrimination, or race and class). In addition, we want to acknowledge the contributions of other critical theorists that have noted how thinking about multiple oppressions can prompt us to generate hierarchies of oppression [79], an insidious logic which advances identity politics over solidarity politics, to the subordination of all. We want to be clear that, while we focused this paper on color-blind racism theory, it is not with the intent to communicate that racism is somehow “the worst” of the various oppressions people maintain and

Table 2
Summary of color-blind racism (CBR) theory and illustrations from engineering education

<i>CBR frame</i>	Abstract liberalism	Naturalization	Cultural racism	Minimization of racism
<i>Bonilla-Silva definition</i>	“involves using ideas associated with political liberalism [...] and economic liberalism [...] in an abstract manner to explain racial matters.” [6, p.76]	“a frame that allows whites to explain away racial phenomena by suggesting they are natural occurrences.” [6, p. 76]	“ a frame that relies on culturally based arguments [...] to explain the standing of minorities in society.” [6, p. 76]	“a frame that suggests discrimination is no longer a central factor affecting minorities’ life chances” [6, p. 77]
<i>Summary of illustration</i>	<p>The expressed worry that unworthy people of color are being admitted to engineering education over worthy White people.</p> <p>The expressed worry that a university would be “lowering its standards” to admit more people of color, because they must be unworthy of admission, while the “lower standards” narrative is not part of discussions when White students are involved</p> <p>The myth of meritocracy persisting in engineering education</p>	<p>The excuse that universities are not admitting more people of color because “they’re not in the applicant pool” or “the pipeline is so small,” while White student admissions go unquestioned</p> <p>The acceptance that students in ESL programs won’t have access to college prep courses in ESL tracks, while native English speakers are expected to take advanced placement courses</p>	<p>The explanation for small numbers of people of color in engineering that not all cultures are equal, or that some do not value engineering</p> <p>“Weed out” models as a norm in engineering education</p> <p>Positioning engineering as about “improving society” rather than about social justice</p>	<p>Failing to acknowledge and intervene in student teams engaging in explicit racism</p> <p>Relying on a K-12 system with acknowledged racist flaws to produce a sufficient supply of diverse and inclusive students.</p>

experience in the United States, including in engineering.¹ As one of us tells her kids, it is not a competition. There are great opportunities for future work in exploring how logics of hierarchies of oppression permeate engineering education culture.

With these caveats, we have found CRT and color-blind racism theory a rich theoretical environment for “shaking up” engineering education work focused on broadening participation,

¹ We appreciate the comments of our anonymous reviewers who remind us to make these points about intersectionality and multiple oppressions.

both empirical research and intervention work. Our intent for offering this deep dive into color-blind racism theory is to prompt other EER researchers to take up this and other CRT offerings and incorporate them into their investigations about why engineering education remains so overwhelmingly White, and for people designing interventions to continue to extend their ambition for change deeper into institutional structure. We offer the following ideas, as potential future directions for others:

- **Unconscious bias:** While engineering education as a community has largely come to acknowledge the role that unconscious bias plays in key admission, hiring, or promotion processes, there is more work to do in unearthing how racism remains in “acceptable” reasonings such as those offered in this paper. *Researchers* interested in unconscious bias could use the framework to analyze speech or writing generated by admission committees, hiring committees, promotion and tenure committees, scholarship committees to see how color-blind racism functions inside excuses regularly offered for why admissions, hiring, or promotion pools remain so White. *Program designers* can use education about color-blind racism theory to create a script of possible counter responses that reject the premises of the framework, provide data of how they are not based in fact, and use that as a take-away from interventions about implicit bias in admissions or hiring or mentoring. This script would, of course, not stand on its own and would need to be offered in the context of broader education helping White people understand their own racial biases and prejudices, and how those are experienced by people of color.
- **Racial attitudes:** With so much attention now focused on unconscious bias, we feel that maybe many White researchers have overlooked the fact that overt racism still exists and is part of the daily experience of many students and faculty of color. *Researchers* could use the color-blind racism framework to explore White students’ and faculty members’ attitudes around race, shifting the lens from people of color to how White people maintain engineering as a predominantly White space. *Program designers* could design interventions to help White people learn how to be better allies to people of color in committee meetings and team meetings, and helping them learn to interrupt color-blind racism expressed by White colleagues both when people of color are present and when they are not.
- **Racial structure:** One of us studies how gender and race is built in to the higher educational institution of engineering education. In this work, we try to understand how people produce policy in the interests of the institution over the interests of the people who participate in the institution. Through what scholars have called “ruling relations” or “relations of ruling” [80-82], it is possible for EER researchers to trace how social relations regarding gender and race are incorporated into the operating procedures for “how we do things” in engineering education. With regard to the current work, we think *researchers* can use the color-blind racism framework to investigate the rationales for policies that function as ruling relations, and *program designers* can help policy makers start to notice where people use color-blind racism to justify what seem to be “normal” policies but which function to maintain engineering education as predominantly White. We are thinking about counterclaims for affirmative action, and anytime people bring up “maintaining standards” in conversations about diversity. We are thinking about helping people to discern the difference between policies/practices that maintain the status quo via meritocratic ideologies or other assimilationist approaches (such as in faculty

development programs, or when we fail to acknowledge different epistemologies students bring into our classrooms) versus policies/practices that challenge these.

We want to acknowledge that using this framework may be difficult for many people, whether researchers or instructors. It can be particularly hard for domestically-born White people, as one of us is, because Whiteness in the U.S. has come to mean that White people can largely avoid conversations about race, and that they have been able to think about their own experience as a raceless “American” experience. Through our experiences thinking and talking about race in engineering education, we have found the following challenges that also make conversations about race difficult:

- That people, particularly White people, don’t want to be perceived as racist;
- That people believe a conversation about race is itself racist, and that having a conversation about race would make them racist;
- That people believe that because race is a social construct that means it is imaginary, and that conversations about race and its real effects somehow will make it more “real”;
- That people recognize conversations about race might mean they are confronted by their own racial privilege, which can be painful and they would rather avoid;
- That people believe that conversations about race and privilege end in the necessity to shift oneself from a passive beneficiary of racism and instead take personal responsibility to help end racism, and that is uncomfortable; and
- That conversations about race somehow unduly spotlight or make uncomfortable the small numbers of students of color or faculty of color we have in our schools, without recognizing the responsibility that White students and faculty have for creating a supportive climate with respect to race.

We also think that one indicator of the importance of using these sorts of theoretical frameworks to understand how engineering education remains so dominated by White people is how embedded the notion of meritocracy is in engineering’s culture, and how a belief in meritocracy is also incorporated into abstract liberalism, the most important frame of Bonilla-Silva’s color-blind racism theory. In engineering, meritocracy may be repurposed as, or operate under the veil of, maintaining an environment of “healthy competition” or “being worthy of the profession” instead of being recognized as a way to leave unquestioned color-blind racist practices and perpetuate racist ideologies about what it means to be an engineer in the United States.

Conclusion

We embarked on this illustrative exploration of Bonilla-Silva’s colorblind racism theory because we think the theory has the potential to expand the imagination of both engineering education researchers and engineering instructors of how race plays out in engineering education at the higher education level. We used this paper to lay out an illustrated argument in order to advance some of the thinking that would be necessary to then use the colorblind racism theory in engineering education research and practice. While there are many ways to continue with this work through research, we hope that this paper serves to continue work that connects practice, policy, and research. As may be noted, the majority of our illustrations stem from experiences that are connected to practice in engineering education not just via teaching, but through our roles in shaping the engineering environment (e.g., hiring, student admissions, faculty governance).

We hope that reading this paper spurs at least some readers to action. On our part, we hope to develop this paper into an archival journal paper, and are exploring ways to adapt this type of work into a tool for engineering educators and administrators. We hope that some more EER researchers explore and adopt theories from CRT, joining a developing community already publishing at ASEE and FIE, and start to methodically investigate engineering education's Whiteness as a manifestation of systemic White supremacy rather than deficiencies expressed by people of color. We hope that instructors begin to notice the times they blame K-12 systems for failing to "supply" engineering education with adequate quantities of people of color for their programs, and start to use their creativity to find ways to circumvent or dismantle policies and practices that were set up to predominantly, and unproblematically, supply White people to engineering education.

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